10/634,686

PATENT SPECIFICATION

1,147,266

DRAWINGS ATTACHED.

1,147,266

Date of Application and filing Complete Specification: 7 March, 1967. No. 10596/67.

Application made in Germany (No. S102,751 Ic/27c) on 25 March, 1966.

Complete Specification Published: 2 April, 1969.

Index at Acceptance:—F1 C(D2J1B, D2J1C, D2J1D, D2J1X, D2J2C2, D2J2D); F1 B(2C3A1, 2C9); F2 C(1C4C2, 1C4E, 1C9B1, 1C10A1, 1C10C4, 10H, 16C, 16E).

Int. Cl.:—F 04 d 27/00.

COMPLETE SPECIFICATION.

Improvements relating to Cooling Fans.

I, MANFRED BEHR, a German citizen trading as SÜDDEUTSCHE KÜHLERFABRIK JULIUS. FR. BEHR, of 5, Mauserstrasse, Stuttgart-Feuerbach, Germany, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to cooling fans, for example cooling fans for internal combustion engines mounted in motor vehicles.

Fans are already known in which, by automatic adjustment of the pitch angle of the fan blades, it is possible to alter the quantity of air passed. To this end, it is known for the fan blade pitch angle to be changed by positive adjustment or by means of a torque actuated adjustment or by the use of flexible blades, the pitch angle thereof being reduced by the air forces. The effect of these known arrangements is that, at relatively high rotary speeds, the fan output is sharply reduced as compared with a non-adjustable fan. In the case of a motor vehicle, with a good input air pressure at relatively high road speeds the thus reduced fan output is sufficient for cooling.

It is also known in the case of motor vehicles to provide fan couplings by which the fan is connected only after a specific maximum temperature of the engine cooling air or water has been exceeded. The mechanical or electromagnetic on-off fan couplings used have the disadvantage of causing a rapid acceleration of the fan and the further disadvantage that, once they have been switched on, they drive the fan at full speed. The couplings which are operated as a function of the engine cooling water temperature or the air temperature behind the radiator have the effect that the fan is switched off completely while the air or cooling water is cold, so economising on fan output in the lower ranges.

The known arrangements have individually different disadvantages. In the case of fans with adjustable blades including fans having flexible blades, there is a continual disturbing noise. With fans in which the blades are rigid but with adjustable pitch angle, in spite of a reduction of the pitch angle, a marked noise is generated at the tips of the blades at relatively high peripheral speeds.

As applied to motor vehicles the adjustable fans have certain strength problems because they are continuously rotating in confined spaces and are repeatedly subjected to pressure surges from interference bodies situated behind them, these surges making heavy demands on their fatigue strength. All adjustable fans have the task of passing the maximum possible quantity of air at lower speeds due to the considerable blade angle. During the cold season of the year, this renders warming-up of the engine difficult since even when the cooling water is prevented from circulating, e.g. by means of a cooling water thermostat, the cold air blown over the engine can disperse considerable quantities of heat.

A fan drive for the cooling of internal combustion engines in motor vehicles is already known where the fan is driven by the internal combustion engine through a coupling which can be disengaged as a function of the cooling water temperature, there being disposed between the automatically engaging and disengaging coupling and the fan a slipping clutch which is likewise known per se and which automatically restricts the maximum rotary speed of the fan to a

specific value. With this arrangement, it is true that the full drive output is required whereas, with a reduced fan speed, the excess portion of the drive is dissipated in the slipping clutch. In the case of a torque actuated fan coupling, however, the disadvantage arises that, in the case of fairly large fans, considerable heat is generated in the coupling and makes it necessary to use uneconomically large coupling members to dissipate the heat.

This invention is aimed at solving the problem of controlling the quantity of air passed by the fan to suit whatever travelling and cooling conditions happen to obtain, a gentle acceleration of the fan being achieved and the occurrence of driving peaks being avoided.

According to the invention there is provided a cooling fan arrangement, for example for internal combustion engines incorporated in motor vehicles, and comprising the combination of the following features:

(a) fan blades whose pitch angle is variable;
(b) coupling means for coupling the fan with a drive shaft and disengaging the fan from the drive shaft, and
(c) temperature responsive means for operating the coupling means in dependence upon the temperature of a fluid medium.

It is thus achieved in a simple manner that the fan comes into operation only when cooling conditions require it, namely when the said fluid medium, which may be for example the cooling air from the fan or the cooling water of an internal combustion engine cooled by the air from the fan, exceeds a specific temperature. Furthermore, the advantage is simultaneously achieved that, with increasing speed, the pitch angle of the fan blades is reduced. At the same time, the blowing of cooling air over the engine of a motor vehicle during starting, so that the heating up time is extended, is avoided. If, on the other hand, after the predetermined air or water temperature has been achieved, the coupling is engaged, then the desired regulation of the quantity of air delivered at relatively high rotary speeds operates and the inadmissible power absorption of the fan shaft or a considerable generation of noise by the heavily-loaded fan running at high speed is avoided.

The invention can be realised in various ways. In the case of combined fan drive, it is possible according to a first embodiment to use a fan the pitch of whose fan blades is self-adjusting. In other cases, it may be advantageous to provide for the fan pitch angle to be adjusted by a device responsive to centrifugal force. It may also be advantageous to use a device to adjust the fan pitch angle as a function of the torque.

A particularly simple embodiment is possible if a fan having flexible blades is used, the blades adjusting automatically under the influence of the air forces.

As coupling devices, it is possible to use electromagnetic arrangements. In order to reduce the demands on the vehicle's electricity supply, it is proposed according to a further feature of the invention to use a mechanical coupling device, a thermostatic element serving to actuate the coupling.

It is also possible to use a temperature-governed viscosity coupling combined with a mechanically simple self-adjusting fan, so achieving the advantage that the fan remains switched off so long as the air behind the radiator is cold, because the coupling has switched to idling. If an increase in the air temperature causes the coupling to be connected, then the desired reduction in the quantity of air passed is not achieved by slipping of the coupling but by the automatic adjustment of the fan blades. The fan coupling can be so constructed that at lowest torque of the adjustable fan, it slips very little, i.e. develops little heat. Therefore, it can remain small in dimensions without excessively high temperatures resulting. By combining a viscosity coupling with the adjustable fan, the advantages of a smooth acceleration are also achieved. Whereas with mechanical or electromagnetic couplings, the top speed of the fan is reached substantially more quickly, a slower rise in speed is reached by the viscosity coupling.

Exemplary embodiments of the invention will now be described in greater detail with reference to the accompanying drawings, in which:—

Figure 1 shows in section a first embodiment;

Figure 1*a* is a section on the line A—B of Figure 1;

Figure 2 shows in section a second embodiment;

Figure 2*a* is a section on the line A—B of Figure 2;

Figure 3 shows in section a third embodiment;

Figure 3*a* is a section on the line A—B of Figure 3;

Figure 4 shows in section a fourth embodiment having a temperature-governed viscosity coupling; and

Figure 4*a* is a section on the line A—B of Figure 4.

In the embodiment of Figure 1, a fan drive shaft 4 is mounted in a bearing flange 1 means of ball bearings 2, 3. On the flange 1 is disposed a shell 5 containing a magnetic coil 6. Connected to the shaft 4 is a v-belt pulley 7. Also mounted on the shaft 4 but freely rotatable relatively thereto

through ball bearings 8 is a star-shaped fan hub 9. On this fan hub 9 is an armature ring 10 which is situated opposite the magnetic coil 6. The fan blades 11 are pivoted to a ring 13 on fan hub 9, through pivots 12. The roots 14 of the fan blades 11 each have a pivot member 15 which engages in a corresponding bore in a ring 16.

When the magnetic coil 6 is energised under the control of a temperature sensing means 31, the magnetic flux through the armature ring 10 causes the star-shaped fan assembly 9 to rotate. With increasing speed, a relative movement occurs between the ring 13 and the ring 16. The pivots 12 move with the ring 13 so that the blades 11 rotate about their pivots 15 in the sense of reducing the angle of pitch.

In the case of the embodiment shown in Figure 2, the fan drive shaft (not shown) is connected to a ring plate 21 on the bearing part 22 of which the fan hub 5 is rotatably supported through ball bearings 23 and 24. Provided in the hub is a thermostatic element 26 which acts on a spring disc 27 which bears on a friction member 28. When the temperature of the cooling air rises, the element 26 acts and the friction element 28 is so tilted by the spring disc 27 that it becomes operatively connected to the plate 21 causing star-shaped member 29 of the fan to rotate. In this embodiment, the fan blades 30 are made from flexible material so that they are automatically adjusted under the influence of the air forces.

The embodiment according to Figure 3 corresponds substantially to the embodiment shown in Figure 1, flexible fan blades being used instead of the pivoted fan blades for varying the fan pitch angle. The magnetic coil 6 is energised under the control of a temperature sensing means 31 immersed for example in the cooling water circuit of an engine of a motor vehicle.

Finally, Figure 4 shows an embodiment of the invention in which a temperature-governed viscosity coupling is provided. By means of a bearing arrangement 41, a bearing part 42 of the star-shaped fan hub is mounted to be freely rotatable on the fan drive shaft 4. Fixedly connected to the shaft is a ring 43 on which there is a coupling disc 44. Secured in a cover part 45 is a bimetallic element 46. When heated, this element bends into the position shown dotted at 47. This causes a valve element 49 to open connecting apertures 50 in the separating wall 51, under the action of a leaf spring 48. The fluid inside the coupling, driven by the coupling disc 44, now becomes circulated in such a manner that the bearing part 42 for the flexible fan blades 30 is caused to rotate.

WHAT I CLAIM IS:—

1. A cooling fan arrangement, for example for internal combustion engines incorporated in motor vehicles and comprising the combination of the following feasures:

(a) fan blades whose pitch angle is variable,
(b) coupling means for coupling the fan with a drive shaft and disengaging the fan from the drive shaft, and
(c) temperature responsive means for operating the coupling means in dependence upon the temperature of a fluid medium.

2. A arrangement according to Claim 1, wherein the pitch angle of the fan blades is self-adjusting.

3. An arrangement according to Claim 1, wherein the pitch angle of the fan blades is adjustable by centrifugal force.

4. An arrangement according to Claim 1, wherein the fan blade pitch angle is adjustable as a function of the fan torque.

5. An arrangement according to Claim 1, wherein the fan has flexible fan blades which adjust their pitch angle automatically under the influence of the air forces.

6. An arrangement according to any one of Claims 1 to 5, wherein said coupling means is electromagnetic.

7. An arrangement according to any one of Claims 1 to 5, wherein said coupling means is mechanical coupling device and is arranged to operate under the control of a thermostatic element.

8. An arrangement according to any one of Claims 1 to 5, wherein said coupling means comprise a fluid coupling.

9. An arrangement according to any one of Claims 1 to 8, wherein temperature responsive means with a bimetallic element serves to control the operation of the coupling means.

10. A cooling fan arrangement substantially as hereinbefore described with reference to Figure 1 or Figure 2 or Figure 3 or Figure 4 of the accompanying drawings.

JENSEN & SON,
Agents for the Applicant,
77, Chancery Lane,
London, W.C.2,
Chartered Patent Agents.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1969.
Published at The Patent Office, 25 Southampton Buildings, London, W.C.2,
from which copies may be obtained.

FIG.1

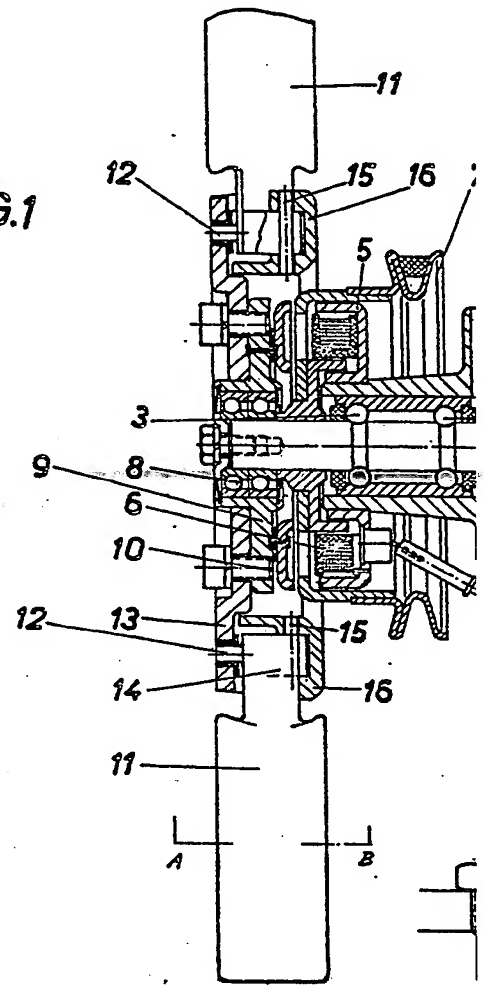


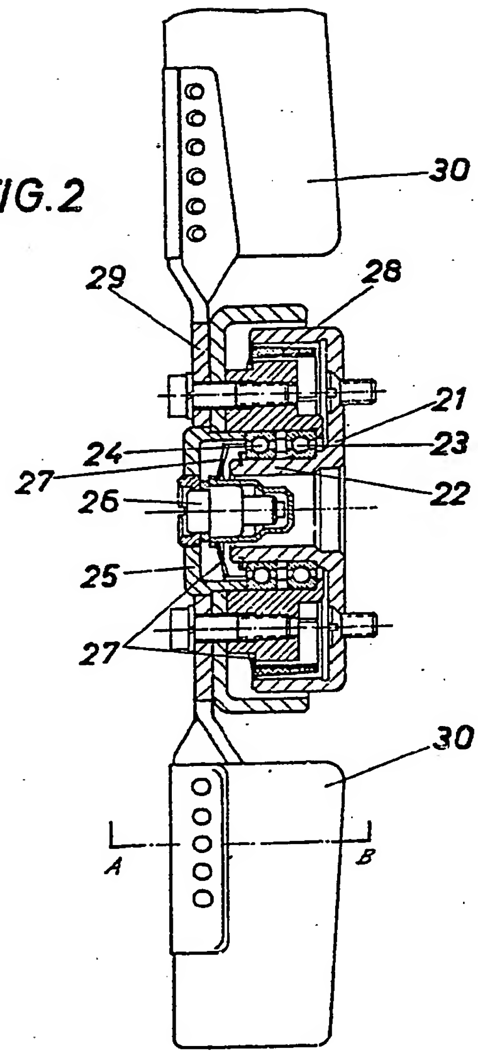
FIG 1a

1147266 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheets 1 & 2

FIG. 2



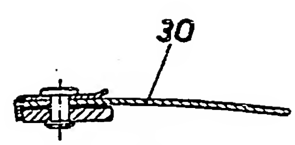


FIG 2a

1147266 COMPLETE SPECIFICATION
4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 1 & 2

FIG.1

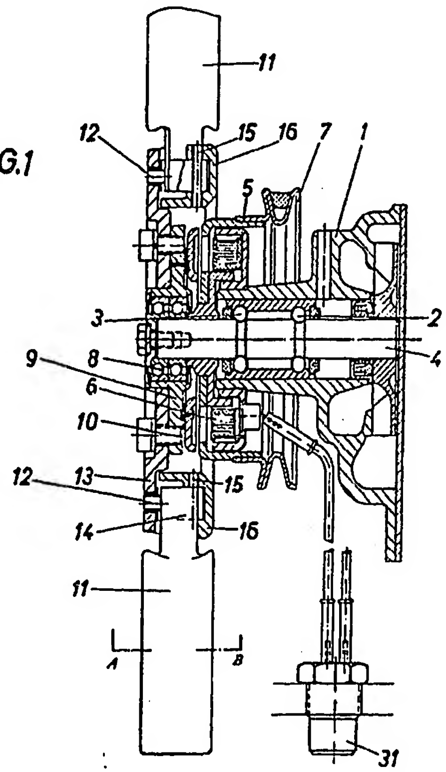
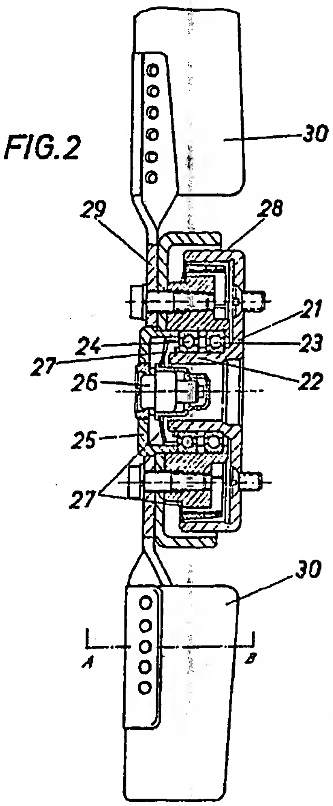


FIG 1a

FIG.2



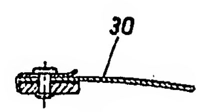
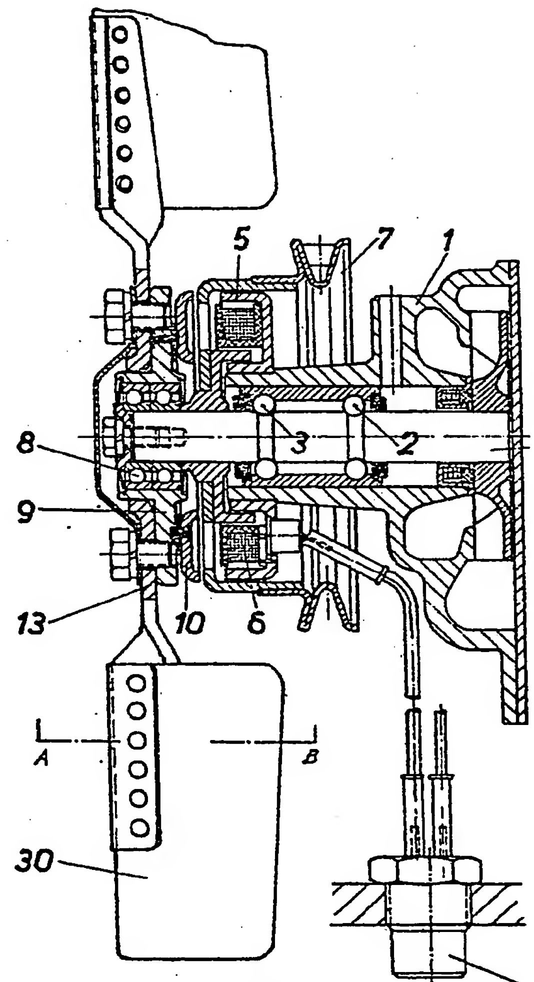


FIG 2a

FIG.3



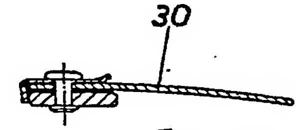


FIG 3a

1147266 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheets 3 & 4

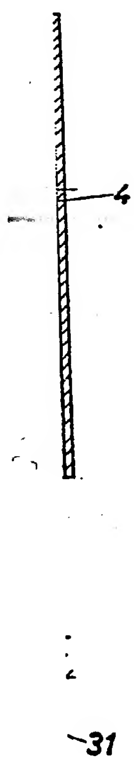
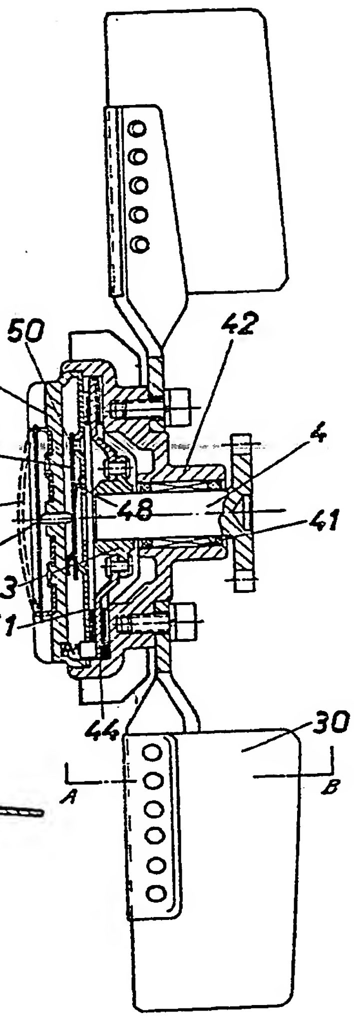


FIG. 4



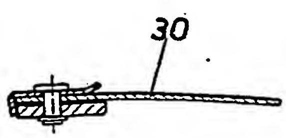


FIG 4a

1147266 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheets 3 & 4

FIG.3

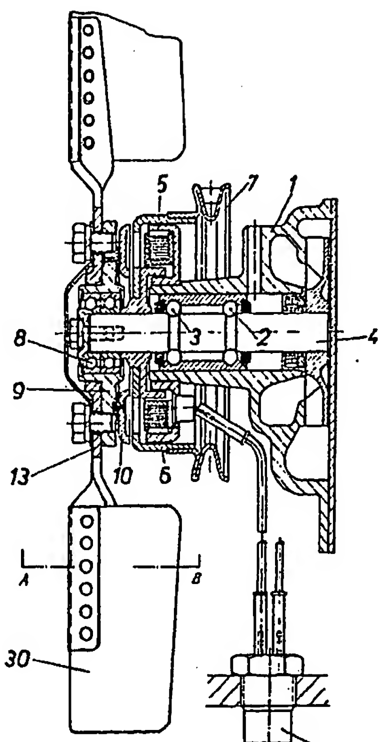


FIG 3a

FIG.4

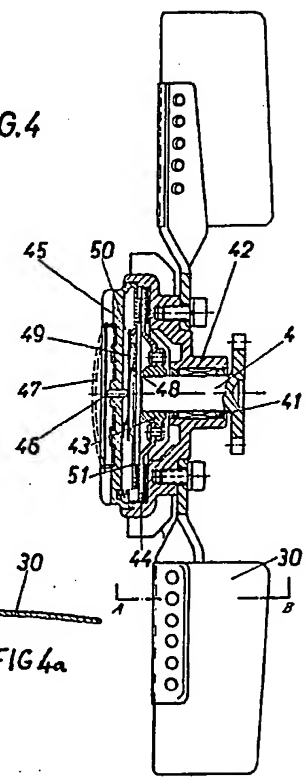


FIG 4a